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Original Article

Artigo Original

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Performance of children at risk for reading difficulties submitted to an intervention program

Desempenho de crianças com risco para dificuldade de leitura submetidas a um programa de intervenção

Keywords

Preschooler
Child
Reading
Learning Disorders
Early Intervention

ABSTRACT

Purpose: To assess the applicability of an intervention program to children at risk for reading disabilities. **Methods:** This experimental study compared 10 children at risk for reading difficulty submitted to a phonological decoding intervention program (study group) with 10 other children at risk for reading difficulty not submitted to the program (control group). The intervention program was based on two international studies. It comprised 24 sessions: the first 12 sessions were conducted with groups of two to three children, whereas the others were performed individually. The sessions lasted 50 minutes and were held twice a week. Statistical analysis was conducted using the Student's t-test and the Wilcoxon Signed-Rank test. **Results:** Children at risk for reading difficulties submitted to the phonological decoding intervention program showed statistically significant improvement at post-assessment in the performance of the following skills: letter naming; phoneme-grapheme relationship; phonological awareness; phonological working memory for non-words; phonological working memory for digits in direct order; alphabet recognition in sequence; writing under dictation of words and pseudowords; reading of words and pseudowords. **Conclusion:** The phonological decoding intervention program showed applicability to improve the prerequisite skills of reading and writing of children at risk for reading disabilities.

Descritores

Pré-escolar
Criança
Leitura
Transtornos de Aprendizagem
Intervenção Precoce

RESUMO

Objetivo: Comparar a aplicabilidade de um programa de intervenção em crianças com risco para dificuldade de leitura. **Método:** Trata-se de uma pesquisa experimental, na qual o grupo estudado de crianças com risco para dificuldade de leitura (formado por 10 crianças) foi submetido ao programa de intervenção de decodificação fonológica para a comparação com o grupo controle de crianças com risco para dificuldade de leitura (formado por 10 crianças), não submetido ao programa de intervenção. O programa foi elaborado com base em dois estudos internacionais, contém 24 sessões, sendo que as 12 primeiras sessões são realizadas em grupos de duas a três crianças e as demais individualmente, as sessões apresentaram duração de 50 minutos e foram realizadas duas vezes por semana. Aplicou-se o teste "t" de *Student* e o teste de *Wilcoxon*. **Resultados:** As crianças com risco para dificuldade de leitura, submetidas ao programa de intervenção de decodificação fonológica, demonstraram melhora na pós-testagem estatisticamente significativa para o desempenho das habilidades de: nomeação de letras; relação grafema-fonema; consciência fonológica; memória de trabalho fonológica para não palavras; memória de trabalho fonológica para dígitos na ordem direta; escrita do alfabeto em sequência; escrita sob ditado de palavras e pseudopalavras; leitura de palavras e pseudopalavras. **Conclusão:** O programa de intervenção de decodificação fonológica mostrou ter aplicabilidade para aprimorar as habilidades de pré-requisitos e as habilidades de leitura e escrita de crianças com risco para dificuldade de leitura.

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INTRODUCTION

National and international researchers have reported that the performance of different abilities is a predictor of the acquisition and development of reading and writing. Phonological processing, phonological awareness, rapid access to mental lexicon, and phonological working memory are among the most frequently cited skills[1,2].

Oral language, phonological awareness, and letter knowledge are the three key domains of early literacy that should be developed to improve the education of children who are at risk for reading problems during preschool[3].

Three risk profiles have been defined for reading difficulties[4]. The first profile comprises children with delayed language development, phonological disorder or specific language impairment (expressive and/or receptive), with difficulty in one or more phonological processing skills, who present non-verbal intelligence scores below, appropriate or above average and absence of primary auditory, visual and motor disabilities. The second profile consists of children who present difficulties typical of the first profile, but with apparently appropriate language development until they are faced with the requirement for segmentation of words into smaller units, thereby presenting difficulties at the beginning of the literacy process, particularly those regarding letter knowledge and sound-letter (phoneme-grapheme) association. In general, these children present phonological disorder history and family history with respect to reading difficulties, have non-verbal intelligence scores below, appropriate or above average, and show no primary auditory, visual and motor impairment. Finally, the third profile refers to children with insufficient experience in preschool, which results in global difficulties in pre-academic skills, with or without phonological disorder history and with history of inadequate exposure to oral language and literacy. These children also present non-verbal intelligence scores below, appropriate or above average and absence of primary auditory, visual and motor disabilities[4].

In this context, any child with difficulties in oral language, phonological awareness, or sound-letter constructions is considered at risk for future disability in reading or writing. Once these difficulties are identified, early intervention should be conducted to minimize or eliminate their impact on school life[4].

Children at risk for reading failure can be identified prior to the literacy process if the following signs are observed during preschool: language delay; phonological disorders; low lexicon level; difficulty learning the alphabet, numbers, colors, days of the week, and shapes; difficulty learning to write their own names, reciting nursery rhymes, or with rhymes; and difficulty with segmentation of words, reading single words, and learning sound-letter relationships[5].

Early identification of children at risk for reading disabilities is only possible if it occurs at the beginning of the literacy process[6].

The teaching of metalinguistic strategies has been the target of interventions proposed for children with learning disorders or disabilities. These interventions aim at the development of attention and perception of speech sounds associated with the phoneme-grapheme conversion[7,8].

The national and international literature describes intervention programs, such as phonological remediation, which involve working with the following skills: sound-letter identification; identification of words within a sentence; identification and manipulation of word syllables; phonemic synthesis; rhyme; identification and discrimination of phonemes; phoneme segmentation; and subtraction, substitution and transposition of phonemes. As a rule, these programs comprise 18 to 24 sessions[7-12].

In recent years, based on systematic literature reviews, some authors[13] have found a considerable number of studies addressing intervention programs for children at risk for dyslexia in the international literature; in contrast, a much smaller number of publications has been found in the Brazilian literature, thus demonstrating the importance to conduct research involving intervention programs focusing on school children at risk for this disorder.

Therefore, it is essential that children at risk for reading disabilities be identified early, allowing early intervention aiming to mitigate future difficulties during the school life of students.

In this context, the purpose of the present study was to assess the applicability of a phonological decoding intervention program to children at risk for reading difficulties.

METHODS

This research was conducted at the Clinical School of the home institution and its analyses meet the criteria of the Research Ethics Committee of the institution. The study was only initiated after its approval by the aforementioned committee under number 489.491/2013.

Study participants were 20 children (both genders; aged 6 to 7 years and 11 months) at risk for reading disabilities who attended the 1st and 2nd grades of elementary school. The participants were divided into two groups:

- Study Group (SG): composed of 10 elementary school children at risk for reading difficulties: two children attending the 1st grade and eight attending the 2nd grade. Children in this group were submitted to the phonological decoding intervention program.
- Control Group (CG): composed of 10 elementary school children at risk for reading difficulties: two children from 1st grade and eight from 2nd grade. Children in this group were not initially submitted to the intervention program.

Inclusion criteria were as follows: children should be enrolled in the 1st or 2nd grades of elementary school; present history of phonological delay or impairment, i.e., belong to the first or second previously mentioned profiles; having their participation in the study agreed by their parents or guardians through the signing of an Informed Consent Form.

Exclusion criteria for participation in the research included presence of visual or auditory acuity and cognitive performance below the normal range; presence of associated pathologies, such as genetic, neurological and neuropsychiatric syndromes or mental disabilities; and previous attendance to speech therapy.

The participants were selected from the waiting list of the Speech-language Pathology outpatient clinic of the home institution;

these children had already been submitted to multidisciplinary clinical diagnosis and had been diagnosed with language delay or phonological disorder.

An anamnestic questionnaire[14] was applied to the children's parents and/or guardians. The participants underwent pre- and post-evaluation comprising the following instruments:

- Phonological Awareness Test – Profile of Phonological Awareness (Pro-PA)[15]: It is composed of items that identify and constitute the following phonological skills: analysis; syllabic analysis; sentence and word segmentation; addition, subtraction and substitution of syllables and phonemes; rhyme reception; sequential rhyme; syllabic reversal; and articulation image.
- Phonological Working Memory Assessment - Non-words and Digits[16]: It is composed of two subtests: the first task consists in the repetition of 40 pseudowords which vary according to the number of syllables - from two to five, whereas the second task consists in the repetition of digits in direct and reverse order.
- Subtest of Alphabet Recognition in Sequence of the Cognitive-Linguistic Performance Test – collective version[17]: It verifies whether the child is able to name the letters that compose the alphabet. Letters that are omitted or named out of sequence are considered as error. One point was assigned to each letter written in the correct order. Children were requested to write the alphabet in sequence on a white, sulfite, A4 size paper sheet.
- Subtest of Writing under Dictation of Words and Pseudowords of the Cognitive-Linguistic Performance Test - collective version[17]: It comprises 30 words and 10 pseudowords. This assessment aims to verify the decoding of high frequency words and pseudowords as well as to check whether the child knows how to spell words of simple and complex syllabic structure.
- Subtest of Reading Words and Pseudowords of the Cognitive-Linguistic Performance Test - individual version[17]: Two subtests comprising 70 words and 10 pseudowords. This test aims to check the decoding of high frequency words and pseudowords (use of the lexical route) as well as to verify whether the child knows the different vowel/consonant types of syllables (C-V, V-C, C-V-C, C-V-V and C-C-V).
- Letter naming and production of letter sound: The 26 letters of the Portuguese alphabet were presented in upper and lower case forms. Participants were requested to name the letters and produce their sounds. This was the only instrument where the number of mistakes made during testing was considered, that is, the lower the number of errors, the better the child's performance.

Following the pre-assessment, children at risk for reading disabilities were submitted to the Phonological Decoding Intervention Program developed by the researchers based on two international studies[18,19]. The program was designed to be conducted in two phases: Phase I and Phase II.

Phase I consists of 12 sessions of 50 minutes conducted with groups of two to three children. In all sessions of this phase, participants were screened with respect to their capacity to name the 26 letters of the Portuguese alphabet in upper and lower case forms; they were also surveyed with regard to the production of the sounds of these letters.

After screening, the examiner trained the group on sound-letter correlation. To this end, each letter of the alphabet was presented printed on cards in black, Cambria font (title), size 200. All letters were presented at random both in uppercase and lowercase. The therapist showed the children the name and sound of each letter, and when the letter had more than one sound, all sounds were presented along with examples of real words.

After training on the phoneme-grapheme relationship, the letters were distributed among the children. The examiner then requested the children to name the grapheme, utter the phoneme, and say a word beginning with the letter. Games aiming to practice the sound-letter correlation were also proposed to reinforce this relationship. To this end, in all of the suggested games, participants were requested to follow the same procedure, that is, name the grapheme, utter the phoneme, and say a word beginning with the letters of the alphabet. The following games were used in the 12 sessions of the first phase: memory game, track game, fishing game, guessing game, and alphabet bingo.

One of the first 12 books of the "Coleção Estrelinha"[20] was read to the group in each of the sessions of the Phase I. During the reading, the researcher pointed each word read to the children and asked them Wh-questions after each page read, aiming to assist in the text comprehension. After reading, using the book read as a reference, each child was requested to perform the segmentation of three phrases and the syllabic segmentation of three words - one monosyllabic, one disyllabic, and one trisyllabic.

Participants were only allowed to start Phase II after having attended the 12 sessions of Phase I and achieved 80% accuracy in the screening for the naming of uppercase and lowercase letters and production of letter sound.

Phase II consists of 12 sessions of 50 minutes. In this phase, participants were screened with respect to naming of uppercase and lowercase letters, production of the sounds of these letters, and revision of the phoneme-grapheme relationship; they were also surveyed with regard to reading of monosyllabic words and pseudowords. For this assessment, the following Portuguese words and pseudowords - presented printed on cards in black, Cambria font (title), size 200 - were used:

Words: *Bar; cor; sol; bom; mar; vem; nós; fez; mel; sim; pá; se; na; no; lá; pé; só; os; ar; um; as; em; ir;* pseudowords: *zal; til; pel; ras; pos; liz; him; xer; lor; tar; pu; ji; ca; ga; ra; fo; hi; or; am; al; er; is; ur; om*.

After assessment, in each of the 12 sessions in Phase II, training was conducted on phonemic segmentation and transposition related to the reading skills of consonant-vowel-consonant (C-V-C) pseudowords. In this practice, the examiner requested the children to read the pseudowords, utter each sound that formed the pseudoword, and then make the transposition of the first and last phonemes of the pseudoword to form a new pseudoword or word. For this assessment, the following

Portuguese pseudowords - presented printed on cards in black, Cambria font (title), size 200 - were used:

Nal; gem; vom; jil; dal; dam; nez; zes; pem; ram; sam; sis; gor; jal; ves.

In the first six sessions of Phase II, stimulation of reading and training of phrase and syllabic segmentation were conducted as described in Phase I, but using the last six books of the "Coleção Estrelinha"[20]. In the last six sessions of Phase II, reading practice was conducted by shared reading, in which the child and the therapist read the pages of the book alternatively. To this end, the first six books of the "Coleção Estrelinha"[20] were used because they present simple phrases and words with simple syllabic structure.

In all, 18 children's books were used in the 24 sessions. All of the books used are part of the "Coleção Estrelinha"[20]. Books one to six present simple phrases and words with simple syllabic structure; books seven to 12 present simple phrases but words with complex syllabic structure; and books 13 to 18 present complex phrases and words with complex syllabic structure. In sessions one to 18, the books were used in increasing order of complexity; whereas in sessions 19 to 24, the first six books of the collection were reused.

The Phonological Decoding Intervention Program stimulates the following skills:

- Naming of uppercase and lowercase letters;
- Production of Letter sound;
- Phonological awareness at the level of awareness of words and syllables and level of phonemic awareness;
- Reading with the objective of understanding small books;
- Reading of C-V-C monosyllabic words.

All study participants underwent pre- and post-test assessments; however, the children in the SG were submitted to the Phonological Decoding Intervention Program for further comparison with those of the CG. It is worth noting that the children in the GC were also submitted to the intervention program in the end of the research, respecting the ethical criteria according to the resolution number 466/12 of the National Health Council.

The 50-minute sessions were conducted by the researcher individually and collectively. The sessions were held in the Speech-language Pathology outpatient clinic of the home institution twice a week. Each child attended three pre-testing sessions, 24 intervention sessions, and three post-testing sessions. The study procedures began in February 2014 and ended in June 2014.

The study results were statistically analyzed using the Statistica v.5.1 (Stat Soft Inc., Tulsa, EUA) software program. Significance level of 5% (0.05) was considered for the applied assessments. Inductive measure analysis was applied to assess the pre- and post-test performance of each group. The Student's t-test was used for normal distribution data and the Wilcoxon Signed-Rank test was applied to the quantitative, non-parametric variables. Also, descriptive analysis was used to determine the mean and standard deviation of the data collected.

RESULTS

The total study sample was composed of 20 children, both genders, aged six to seven years and 11 months, enrolled in the 1st and 2nd grades of elementary school. Participants were divided into two groups of 10 children (two from the 1st grade and eight from the 2nd grade): study group (SG) and control group (CG).

Results show that participants of the SG improved their phonological awareness after participation in the intervention program, considering that significant difference was observed in the total assessment and subtests with respect to analysis; sentence and word segmentation; addition, subtraction and substitution of syllables and phonemes; syllabic reversal; and articulation image. The same was not observed for participants in the CG, though (Table 1). Nevertheless, no significant difference was found in the subtests for rhyme reception and sequential rhyme in either group.

Significant difference was found in the pre- and post-assessments for the SG regarding phonological working memory for the total of non-words, direct order, and total of digits. As for the CG, improvement was observed only with respect to five-syllable words (Table 2).

Regarding the performance of reading and writing skills (Table 3), participants of the SG showed improvement in the reading and writing of words and pseudowords after intervention, whereas no improvement was found for these skills in the CG.

Finally, quantification of errors during the naming of uppercase and lowercase letters and production of letter sound (Table 4) showed significant difference for the SG, but not for the CG.

DISCUSSION

The phonological decoding intervention program used in this study stimulates the skills of uppercase and lowercase letter naming, production of letter sound, reading, and the phonological awareness of words, syllables and phonemes aiming at the understanding of small books and the reading of C-V-C monosyllabic words.

Concerning the skills directly stimulated by the intervention program, that is, those trained during the sessions in the phonological awareness assessment, participants of the SG presented significantly improved scores in the subtests that evaluated reception of rhymes and sequential rhyme, which may have occurred as a consequence of the stimulation provided by the program, considering that the skills of phonological awareness were not stimulated or trained.

Similar results were also reported in a study that used a remediation program with no rhyme training[10]; however, another study[7] that used a remediation program with rhyme stimulation also reported significant improvement of this skill.

Nevertheless, younger children have greater facility to cope with activities involving syllables, alliteration, and rhymes than with those comprising phonemes due to spontaneous development of awareness of supraphonemic segments[21]. This spontaneous development was not observed in the groups investigated or in the studies cited.

Table 1. Performance of children on the pre- and post-assessment of phonological awareness skills

Variable	Group	Assessment time	Mean	Standard deviation	p value
Analysis	SG	Pre	11.90	3.21	**0.0003***
		Post	15.10	1.73	
Analysis	CG	Pre	9.10	5.40	0.4016
		Post	10.00	5.96	
Addition	SG	Pre	4.50	1.27	**0.0002***
		Post	6.40	1.26	
Addition	CG	Pre	4.20	0.79	1.0000
		Post	4.20	0.63	
Segmentation	SG	Pre	6.60	2.59	**0.0086***
		Post	9.00	1.79	
Segmentation	CG	Pre	7.00	1.94	0.7803
		Post	6.90	1.97	
Subtraction	SG	Pre	2.70	2.16	**0.0031***
		Post	5.10	1.91	
Subtraction	CG	Pre	2.60	2.22	0.8321
		Post	2.70	2.06	
Substitution	SG	Pre	1.30	0.95	**0.0085***
		Post	2.30	0.82	
Substitution	CG	Pre	1.30	1.25	0.7577
		Post	1.20	1.03	
Rhyme reception	SG	Pre	5.40	1.90	0.1381
		Post	6.40	2.63	
Rhyme reception	CG	Pre	5.20	1.93	0.4226
		Post	5.80	2.20	
Sequential rhyme	SG	Pre	5.20	1.03	0.2788
		Post	4.60	1.35	
Sequential rhyme	CG	Pre	4.60	1.35	0.1039
		Post	3.80	1.47	
Syllabic reversal	SG	Pre	1.00	0.94	**0.0223***
		Post	1.80	1.13	
Syllabic reversal	CG	Pre	0.50	0.53	0.1773
		Post	1.00	0.82	
Articulation image	SG	Pre	6.00	2.11	**0.0293***
		Post	7.80	0.63	
Articulation image	CG	Pre	6.60	2.12	0.2012
		Post	5.80	2.20	
TOTAL	SG	Pre	43.80	9.70	**0.0000***
		Post	58.50	8.66	
TOTAL	CG	Pre	41.10	11.81	0.8828
		Post	41.40	13.26	

*Significant values ($p<0.05$) – Student's t-test and Wilcoxon Signed-Rank test
Caption: SG: Study Group; CG: Control Group; SD: Standard Deviation

Table 2. Performance of children on the pre- and post-assessment of phonological working memory skills

Variable	Group	Assessment time	Mean	Standard deviation	p value
NW 2	SG	Pre	18.90	2.18	**0.1088***
		Post	19.90	2.12	
NW 2	CG	Pre	19.00	1.33	0.3938
		Post	18.70	1.16	
NW 3	SG	Pre	19.20	1.32	0.3452
		Post	18.40	2.12	
NW 3	CG	Pre	16.90	2.47	0.8321
		Post	17.10	2.28	
NW 4	SG	Pre	14.20	4.47	0.5910
		Post	14.00	3.53	

*Significant values ($p<0.05$) – Student's t-test and Wilcoxon Signed-Rank test
Caption: NW 2: 2-syllable non-words; NW 3: 3-syllable non-words; NW 4: 4-syllable non-words; NW 5: 5-syllable non-words; TOTAL NW: Total for non-words; DD: Digits in direct order; DI: Digits in reverse order; TOTAL D: Total for digits; SG: Study Group; CG: Control Group; SD: Standard Deviation

Table 2. Continued...

Variable	Group	Assessment time	Mean	Standard deviation	p value
NW 4	CG	Pre	11.10	5.55	0.7077
		Post	10.80	5.39	
NW 5	SG	Pre	6.90	6.30	0.0839
		Post	11.00	6.62	
NW 5	CG	Pre	8.30	5.87	**0.0367***
		Post	9.50	6.19	
TOTAL NW	SG	Pre	56.90	11.93	**0.0151***
		Post	64.20	11.06	
TOTAL NW	CG	Pre	55.30	12.57	0.4664
		Post	56.10	12.05	
DD	SG	Pre	13.70	3.09	**0.0414***
		Post	14.60	3.24	
DD	CG	Pre	13.90	5.13	0.0528
		Post	15.50	3.66	
DI	SG	Pre	5.70	2.26	0.4620
		Post	6.10	1.85	
DI	CG	Pre	5.40	3.06	0.7698
		Post	5.60	2.76	
TOTAL D	SG	Pre	19.40	5.10	0.0962
		Post	20.70	4.47	
TOTAL D	CG	Pre	19.30	7.26	0.1404
		Post	21.10	6.00	

*Significant values (p<0.05) – Student's t-test and Wilcoxon Signed-Rank test
Caption: NW 2: 2-syllable non-words; NW 3: 3-syllable non-words; NW 4: 4-syllable non-words; NW 5: 5-syllable non-words; TOTAL NW: Total for non-words; DD: Digits in direct order; DI: Digits in reverse order; TOTAL D: Total for digits; SG: Study Group; CG: Control Group; SD: Standard Deviation

Table 3. Performance of children on the pre- and post-assessment of reading and writing skills

Variable	Group	Assessment time	Mean	Standard deviation	p value
WA	SG	Pre	18.20	7.77	**0.0158***
		Post	20.40	6.28	
WA	CG	Pre	19.60	7.34	0.8438
		Post	19.80	6.94	
WW	SG	Pre	5.70	5.79	**0.0058***
		Post	12.00	7.89	
WW	CG	Pre	7.80	6.94	0.1824
		Post	9.40	7.70	
WNW	SG	Pre	0.90	0.99	**0.0039***
		Post	3.00	2.16	
WNW	CG	Pre	3.20	4.54	0.2471
		Post	4.00	3.80	
TOTAL W	SG	Pre	6.60	6.57	**0.0034***
		Post	15.00	9.96	
TOTAL W	CG	Pre	7.00	6.68	0.0616
		Post	10.00	10.26	
RW	SG	Pre	24.20	21.25	**0.0019***
		Post	47.00	26.73	
RW	CG	Pre	29.40	25.43	0.0565
		Post	32.50	25.69	
RNW	SG	Pre	3.90	3.38	**0.0057***
		Post	7.00	3.85	
RNW	CG	Pre	3.90	3.45	0.5910
		Post	3.60	3.24	

*Significant values (p<0.05) – Student's t-test and Wilcoxon Signed-Rank test
Caption: WA: Writing the alphabet; WW: Writing of words; WNW: Writing of non-words; TOTAL W: Total for writing; RW: Reading of words; RNW: Reading of non-words; SG: Study Group; CG: Control Group; SD: Standard Deviation

Table 4. Performance of children on the pre- and post-assessment for the skills of letter naming and production of the sounds of uppercase and lowercase letters

Variable	Group	Assessment time	Mean	Standard deviation	p value
NUL	SG	Pre	5.90	6.40	**0.0044***
		Post	1.40	3.10	
NUL	CG	Pre	3.50	4.20	0.8226
		Post	3.40	3.84	
NLL	SG	Pre	9.30	6.40	**0.0005***
		Post	1.60	3.72	
NLL	CG	Pre	7.40	5.72	0.1401
		Post	6.10	5.88	
PLS	SG	Pre	21.50	3.57	**0.0000***
		Post	2.10	3.18	
PLS	CG	Pre	21.40	7.92	0.3452
		Post	21.90	7.28	

*Significant values (p<0.05) – Student's t-test and Wilcoxon Signed-Rank test
Caption: NUL: Naming of uppercase letters; NLL: Naming of lowercase letters; PLS: Production of letter sound; SG: Study Group; CG: Control Group; SD: Standard Deviation

Other intervention studies conducted with children in the beginning of the literacy process, children with learning disabilities, or children at risk for reading failure, which included training of phonological awareness, also showed similar results of improved phonological awareness and reading and written skills after intervention[22-24].

After the intervention, participants of the SG showed significant improvement in the knowledge of the names and sounds of letters. However, participants of the CG did not show improvement in the post-assessment, which demonstrates that children do not present improvements spontaneously or because of stimulation provided by the school, and that the improvement observed in the participants of SG occurred as a result of the intervention. A study[3] also described significant difference between pre- and post-assessment results for knowledge of the names and sounds of letters in children at risk for reading problems who received training on letter knowledge. Similar results were also reported in other intervention works with children at risk for reading difficulties[22,23].

A study[25] used an intervention program that stimulated phonemic awareness, the phoneme-grapheme relationship, and the oral reading of books. The program was applied to 152 children under five years of age, with poor verbal skills, identified as at risk for difficulties in reading and writing. Results obtained after the intervention showed significant improvement in the knowledge of the names and sounds of letters, phonological awareness, phonemic awareness, and the skill of reading and writing of words.

As for the skills of reading words and pseudowords, significant increases were observed in the children of the SG after the intervention, whereas the children of the CG did not improve their performance.

The metalinguistic skills of syllabic awareness, phonological awareness, and knowledge of the name of letters, stimulated by the intervention program, are strongly correlated with the skills of reading words, in which the greater development of phonological awareness skills leads to a greater development of reading skills, as well as the knowledge of the name of letters enhances the ability to perform the phoneme-grapheme relationship[26]. Therefore, the evolution of the children of the SG with respect to the reading of words and pseudowords may be related to the development of metalinguistic skills.

Intervention studies[18,19] showed that stimulation of letter naming and grapheme-phoneme relationship, along with the direct practice of reading of C-V-C monosyllabic non-words, result in the dissemination of trained reading skills for the reading of untrained words and pseudowords of different lengths and syllabic structures. This finding suggests that the program prepared and applied in this study also produced the widespread of the reading skill.

Therefore, considering the three-month time gap between the pre- and post-assessments, it is possible to state that the participants of the SG did not have their reading skill enhanced by the stimulation offered by the school. This fact corroborates the findings of other studies which show that school children diagnosed or at risk for reading difficulties not submitted to interventions did not present spontaneous improvement of reading and writing skills[11,27].

Nevertheless, the phonological and writing working memory skills were not directly stimulated by the intervention program used, considering that strategies were not used with the aim of training these abilities during the sessions; even so, the children of the SG had these skills improved.

However, both of the aforementioned skills were stimulated indirectly, because the same strategies and objectives were used in all sessions. With respect to writing, phonological awareness has been associated with this ability, playing an important role in the acquisition of the alphabetic writing system;[28] therefore, improved phonological awareness positively influences writing.

This way, significant improvement was observed in the writing of words and pseudowords, which was verified in the increased number of these terms spelled correctly by participants of the SG in the subtest of writing under dictation of words and pseudowords. The means for the writing of words of this group, after the intervention, did not reach the expected level for their schooling; however, qualitative improvement was observed for

writing, considering that, before the intervention, these children presented difficulty to perform the phoneme-grapheme correlation when writing, which was not observed after the intervention. Nevertheless, mistakes owing to language irregularities and/or to contextual rules were found.

Other intervention studies that stimulate phonological awareness and/or knowledge of the alphabet show improved writing after the intervention, even when this skill is not being directly trained[29].

A study[30] reported high correlation between phonological awareness and written language, and the correlation between these skills is significant in children aged five to six years.

The improvement observed in the participants of the SG in the comparison of pre- and post-assessment was not found in the children of the CG. This finding suggests that, although writing was not directly trained in the intervention program, it was incremented by it, considering that the participants of the CG continued to receive school instruction during the three months of the research, but only the participants of the SG were submitted to the Phonological Decoding Intervention Program.

Participants of the SG showed significant improvement in the working memory skill for the total score for non-words and digits in direct order. A phonological remediation program applied to students with learning disabilities showed improvement in the skill of phonological working memory[29].

Children at risk for dyslexia submitted to phonological intervention associated with phoneme-grapheme correlation also showed significant improvement in the phonological working memory ability, whereas a group of children not at risk or subjected to the program did not have this skill improved[23].

CONCLUSION

The Phonological Decoding Intervention Program showed applicability to enhance the prerequisite skills of reading and writing of children at risk for reading disabilities, considering that significant improvement was observed regarding the skills of letter knowledge, phonological awareness, phonological working memory, and reading and writing of words and pseudowords.

The phonological decoding intervention program was designed to be applied to children at risk for reading difficulties, aged six to seven years and 11 months, enrolled in the 1st and 2nd grades of elementary school. Therefore, the activities of the program herein assessed were proposed for this population.

It is worth mentioning that children at risk for reading disabilities require additional stimulation, considering that the children who were stimulated with respect to their knowledge on letter naming, production of letter sound, and phonological and reading awareness presented significant improvement in the skills of phonological processing and reading and writing.

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Author contributions

NSMS participated in the design and scheduling of the study, literature review, collection and analysis of data, and writing, submission, and procedures of the manuscript; PAPC was the research adviser, participated in the design and scheduling of the study, literature review, analysis of data, and revision of the final version of the manuscript.